

Cooling of a stator

The invention relates to the cooling of a stator of an
5 electric machine, the stator comprising an autonomous
cooling circuit, that is to say distinct from another
cooling circuit such as that of a rotor of the electric
machine, for example. The invention is particularly
suitable for cooling an electric machine operating at
10 high temperature and cooled by oil circulation. The
temperature of the oil is, for example, between 100 and
140°C. The cooling circuit must be sealed between the
oil-immersed stator and the rotor assembly at the
location of a gap separating the rotor from the stator.

15 Sealing has been provided for the cooling circuit by
means of a fluidtight shell fixed to the stator and
arranged in the gap. This type of sealing provision
entails numerous constraints. It is absolutely
20 essential for the shell, situated in the gap, to be
electrically non-conductive so as not to produce losses
which would be detrimental. It must be as thin as
possible since it either constitutes an additional
electromagnetic gap (if it is non-magnetic) or it
25 increases magnetic leakage (if it is magnetic).
Finally, it must provide oil sealing over the whole
length of the machine. Its outer face is exposed to the
relatively low temperature of the oil circulating in
the stator, but its internal face is exposed to the
30 high temperature of the air present in the gap. The
shell must have sufficient mechanical properties to
withstand this high temperature gradient and also to
retain its dimensions and not deform in the gap. All of
these constraints may be summarized to the production
35 of a thin fluidtight cylindrical shell using an
electrically non-conductive material capable of
withstanding these high temperatures without deforming.

The object of the invention is to simplify the production of the shell while eliminating a large number of the constraints mentioned above. To this end, the subject of the invention is a stator of an electric machine comprising an autonomous cooling circuit, means for sealing the cooling circuit with respect to a rotor of the electric machine, a magnetic circuit comprising slots, and a winding arranged in the slots, characterized in that the sealing means comprise a fluidtight shell sandwiched in the magnetic circuit.

The invention finds particular utility in electric machines requiring high leakage inductance. For example, when the machine is an alternator, the leakage inductance makes it possible to reduce the short-circuit current in the event of a fault. To increase the leakage inductance, slots are produced which are deeper than required for filling the winding in the slots. The shell may then be sandwiched inside the magnetic circuit and the whole of the winding may nevertheless be arranged outside the shell and thus be cooled by the cooling circuit.

The invention will be better understood and other advantages will emerge on reading the detailed description of an embodiment of the invention given by way of example, the description being illustrated by means of the appended drawing, in which:
figure 1 represents, in partial section, an electric machine comprising a stator according to the invention;
figure 2 represents an angular sector of the stator of figure 1, shown in section through a plane perpendicular to the section plane of figure 1.

Figure 1 represents an electric machine 1 comprising a rotor 2 whose details are not represented, together with a stator 3 fastened to the inside of a housing 4 formed by two parts 5 and 6. The rotor 2 and the stator 3 are separated by a gap 25. The stator 3 comprises a

two-part magnetic circuit whose parts 7 and 8 are separated by a shell 9. Thus, the shell 9 is sandwiched in the magnetic circuit. The housing 4 and the shell 9 form a fluidtight enclosure 10 inside which a fluid for 5 cooling the stator 3 circulates. Oil is used as cooling fluid, for example. One or more O-ring seals may be placed between the housing 4 and the shell 9 to improve sealing at the interface between the shell 9 and the housing 4. In the example represented, two seals 11 and 10 12 have been used.

Advantageously, the shell 9 is of tubular shape and is centered around an axis 13 of revolution of the electric machine, and the magnetic circuit comprises a 15 first stack of laminations 7 produced outside the shell 9 and a second stack of laminations 8 produced inside the shell 9. The laminations 7 and 8 are planar and perpendicular to the plane of figure 1.

20 Figure 2 represents in section an angular sector of the stator 3 through a plane perpendicular to the axis 13. A complete view of the stator 3 can be obtained by duplicating the angular sector about the axis 13.

25 The first stack of laminations 7 comprises slots 14 inside which a winding 15 is arranged. The winding 15 is, for example, formed by copper bars 16 of rectangular cross section. The slots 14 advantageously have a constant width corresponding to the cross 30 section of the bars 16. Passages 17 are advantageously made between the bars 16. The cooling fluid circulates in the passages 17 in order to cool the winding 15 and all of the stator 3. The winding is arranged at the bottom of the slots 14. The filling of each slot 14 may 35 be completed by placing a block 18 made of an insulating material such as a glass-fiber-reinforced resin. The block 18 advantageously comprises passages 17 in order to improve the cooling of the stator 3.

The shell 9 is arranged between the first stack of laminations 7 and the second stack of laminations 8. Thus, the shell 9 is no longer directly exposed to the air in the gap 25 nor to its high temperature as in the 5 prior art described above.

The second stack of laminations 8 also comprises slots 20 arranged in the continuation of the slots 14 of the first stack of laminations 7. Advantageously, the 10 second stack of laminations 8 comprises bridges 21 which close the slots 20, the bridges 21 being situated in the immediate vicinity of the gap 25.

Using the bridges 21 to close the slots 20 constitutes 15 a simple, direct alternative to fitting magnetic blocks in open, straight slots. These blocks would have had to be provided in any event in order in particular to greatly reduce the losses at the surface of the rotor 3, these losses being considerable in the case of a 20 solid band. The bridges 21 are directly produced with the laminations of the second stack of laminations 8. This avoids possible contact faults between laminations forming open slots and magnetic blocks added to close the slots.

25 The second stack of laminations 8 may serve as a mechanical support for the shell 9. This allows the use of materials which do not have the mechanical properties of a shell of the prior art. For example, it 30 is not necessary for the shell 9 to be self-supporting. A simple fluidtight coating may be used for example to form the shell 9. The coating is deposited on one of the stacks of laminations 7 or 8. Use is made, for example, of a composite material comprising glass 35 fibers embedded in resin to produce the coating.

The position of the shell 9 with respect to the combined depth of the slots 14 and 20 may be adjusted as a function of the various production constraints,

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within a range corresponding to the height of that part
of the stator 3 which is not filled with copper.